

EXTENDED REPORT

Smoking and musculoskeletal disorders: findings from a British national survey

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Objectives: To explore the relation between smoking habits and regional pain in the general population.

Methods: A questionnaire was mailed to 21 201 adults, aged 16–64 years, selected at random from the registers of 34 British general practices, and to 993 members of the armed services, randomly selected from pay records. Questions were asked about pain in the low back, neck, and upper and lower limbs during the past 12 months; smoking habits; physical activities at work; headaches; and tiredness or stress. Associations were examined by logistic regression and expressed as prevalence ratios (PRs).

Results: Questionnaires were completed by 12 907 (58%) subjects, including 6513 who had smoked at some time, among whom 3184 were current smokers. Smoking habits were related to age, social class, report of headaches, tiredness or stress, and manual activities at work. After adjustment for potential confounders, current and ex-smokers had higher risks than lifetime non-smokers for pain at all of the sites considered. This was especially so for pain reported as preventing normal activities (with PRs up to 1.6 in current v never smokers). Similar associations were found in both sexes, and when analysis was restricted to non-manual workers.

Conclusions: There is an association between smoking and report of regional pain, which is apparent even in ex-smokers. This could arise from a pharmacological effect of tobacco smoke (for example, on neurological processing of sensory information or nutrition of peripheral tissues); another possibility is that people with a low threshold for reporting pain and disability are more likely to take up and continue smoking.

A positive association has been found between smoking and back pain in many,^{1–3} but not all,^{6–8} of the epidemiological surveys that have examined the link. In some, a dose-response relationship has been described,^{3–5} and in a few prospective studies, smoking habits have been found to predict episodes of incident back pain.^{9–10}

Several explanations for the association have been proposed. Smoking might provoke disc herniation through coughing, or lead to pathological changes in the intervertebral disc through alterations in its nutrition,¹¹ pH,¹² or mineral content.⁹ Another possibility is that smoking has a pharmacological effect on pain perception. Alternatively, the association could be confounded by physical occupational activities that are more common in workers who smoke; or by neuropsychological or sociocultural factors (for example, threshold for reporting symptoms and illness behaviour) that differ systematically between those who become smokers and those who do not.^{13–15}

In a few studies, an association has also been described between smoking and pain at other body sites, including the neck,¹⁴ shoulder,¹⁵ and legs.¹⁶ An association with widespread pain would tend to favour a central or systemic rather than a local mechanism, and contrasting risks in current and ex-smokers might argue against confounding as an explanation. To investigate further, we explored the relation of smoking habits to musculoskeletal pain at various anatomical sites, using data from a postal survey of a community sample.

METHODS

In 1997–8, we mailed a questionnaire to 21 201 men and women aged 16–64 years, selected at random from the patient lists of 34 general practices in England, Scotland, and Wales, and to a further 993 subjects selected at random from central

pay records for serving members of the British armed services.^{17–18} A single reminder was sent to non-responders after five weeks.

The study was undertaken primarily to assess national patterns of occupational exposure to vibration and associated health complaints, but the questionnaire, which has been fully described elsewhere,¹⁹ included items on smoking habits, as well as a modified version of the Standardised Nordic Questionnaire of musculoskeletal symptoms.²⁰ Inquiries were made about regional pain (in the neck, shoulders, elbows, wrists/hands, hips, and knees) lasting a day or longer in the past 12 months, including symptoms that prevented the respondent from carrying out his or her normal activities, such as paid work, housework, or hobbies. A question was also posed about low back pain—defined as back pain lasting a day or longer during the previous 12 months in an area between the 12th ribs and the gluteal folds (indicated by means of a diagram), and about sciatica (low back pain which radiated down the leg to below the knee) and “troublesome” low back pain (that is, low back pain which had made it difficult or impossible to put on shoes, stockings, or tights).

Details were collected on other personal and occupational factors considered relevant to the assessment of reported musculoskeletal symptoms—namely, (a) complaints of frequent headaches or of often feeling tired or stressed; (b) employment status and occupation; (c) (among subjects in paid work) exposure to certain specific physical activities—namely, (in an average working day) lifting or moving weights of 20 lb (10 kg) or more by hand, digging or shovelling, working with the hands above shoulder height for more than one

Abbreviations: PR, prevalence ratio; 95% CI, 95% confidence interval

Table 1 Prevalence of smoking by age, sex, social class, and reported symptoms

	Men (%)				Women (%)			
	Men* (n)	Never smoked	Formerly smoked	Currently smoke	Women* (n)	Never smoked	Formerly smoked	Currently smoke
Age:								
16–24	814	63.3	10.9	25.8	787	59.2	12.2	28.6
25–34	1516	53.7	17.7	28.6	1395	55.1	18.5	26.5
35–44	1609	48.6	25.3	26.1	1424	57.0	21.7	21.3
45–54	1652	37.0	36.3	26.8	1299	50.4	27.9	21.6
55–64†	1317	30.6	48.8	20.7	1089	52.0	27.2	20.8
Social class:								
I, II, IIIM	2279	55.0	28.4	16.6	2610	57.7	23.6	18.8
IIIM, IV,V	2499	40.5	29.2	30.4	1100	49.8	22.2	28.0
Unemployed	1423	36.8	32.0	31.2	2116	52.7	20.6	26.8
Armed forces	560	48.6	23.9	27.5	67	56.7	11.9	31.3
Often feeling tired or stressed:								
No	4879	48.3	28.9	22.8	3698	58.0	22.4	19.6
Yes	1961	37.5	29.4	33.1	2231	48.9	21.3	29.9
Frequent headaches:								
No	6107	46.0	29.4	24.7	4723	55.9	22.1	22.0
Yes	653	38.1	26.3	35.5	1188	49.6	22.1	28.4

*Maximum number—a few subjects failed to answer all the questions.

†Includes 33 men and 39 women who were 64 years old when the questionnaire was mailed but 65 at the time of response.

hour, use of a computer keyboard or typewriter for more than four hours, and (in the past week) exposure to sources of hand transmitted or whole body vibration.

A smoker was defined as someone who had smoked at least once a day for a month or longer, and classed according to whether he or she still smoked regularly at the time of completion of the questionnaire (current smoker) or did not (former smoker).

The prevalence of each category of smoking status was determined by age, sex, social class, and reported frequency of headaches, tiredness, and stress; and, after direct standardisation for age and sex, according to physical occupational activities. Associations of regional pain with smoking status were examined by logistic regression with adjustment for potential confounders, and the findings were expressed as prevalence ratios (PRs) with associated 95% confidence intervals (95% CIs). These were derived from the corresponding odds ratios according to a formula proposed by Zocchetti *et al.*²¹

RESULTS

Usable responses were obtained from 12 907 (58%) of those mailed. Altogether, 6513 subjects (3786 men and 2727 women) reported smoking at some time, among whom 3184 (1779 men and 1405 women) were current smokers.

Table 1 shows the relation of smoking habits with age, social class, and employment status, and report of frequent headaches or often feeling tired or stressed. The proportion of lifetime non-smokers fell with age and that of ex-smokers rose, current smoking being somewhat more common among younger age bands. Current smoking also showed a gradient with socioeconomic status, being more common in manual workers and unemployed people than in non-manual workers; and a greater proportion of subjects who reported frequent headaches or frequent tiredness and stress currently smoked.

Those undertaking physical activities at work were more often smokers. The association between smoking status and regional pain was therefore examined after adjustment for age, sex, the occupational activities ascertained, and complaints of frequent headaches, tiredness, or stress (table 2).

In comparing those who had smoked with lifetime non-smokers, increased risks were found at all of the sites considered (neck, upper limbs, back, and lower limbs), and associations were found both for ex-smokers and current

smokers. Higher risks were found for pain associated with disability than for pain alone, the highest risk (with PRs up to 1.6) being for pain that prevented normal activities in current smokers.

When the associations were explored separately for each sex, and in an analysis restricted solely to white collar workers, similar patterns and strengths of association were found (data not presented). Similar associations were also found in those who responded to the questionnaire at the first invitation and those who required a reminder.

DISCUSSION

Our data indicate a modest but consistent association between smoking and regional musculoskeletal pain which was not confined to the low back, but was apparent at all of the sites considered. The relation was evident even in ex-smokers, although stronger for current smoking and for pain associated with reported disability.

Participation was incomplete (response rate 58%), and the associations could have arisen if current and ex-smokers who were in pain returned their questionnaires more readily than other smokers, whereas a similar differential response did not occur in non-smokers. This seems unlikely, however, as similar associations were found in early responders and those who only replied after a reminder. (For example, the PRs for hand and elbow pain preventing activity were exactly the same among current smokers in the two groups, and the PRs were respectively 1.5 versus 1.4 for neck pain and 1.6 versus 1.5 for shoulder pain.)

Current and ex-smokers were more likely to have a physically demanding occupation (a possible source of confounding), and more often reported feelings of frequent tiredness, stress, and headaches (which could indicate a lower threshold for reporting symptoms in general); but the pattern persisted in an analysis that adjusted for these factors and when analysis was restricted solely to white collar workers. Also, some people might have taken up or resumed smoking because of pain, although this would not readily explain the association found in ex-smokers. In addition, the association could in part reflect higher rates of smoking among subjects with inflammatory arthropathies (as has been reported for rheumatoid arthritis²²). However, the prevalence of such disorders in the general population is too low for this to have had a major impact.

Table 2 Risk of regional musculoskeletal pain according to smoking status

Site															
Neck															
n*	%	PR (95% CI)	%	PR (95% CI)	%	PR (95% CI)	%	PR (95% CI)	%	PR (95% CI)	%	PR (95% CI)	%	PR (95% CI)	
Pain in the past year:															
Never smoked	6063	32	1.0	29	1.0	11	1.0	22	1.0	15	1.0	30	1.0	44	1.0
Formerly smoked	3144	38	1.1 (1.1 to 1.2)	37	1.2 (1.1 to 1.2)	18	1.3 (1.2 to 1.5)	29	1.2 (1.1 to 1.3)	21	1.2 (1.1 to 1.3)	37	1.1 (1.1 to 1.2)	55	1.2 (1.1 to 1.2)
Currently smoke	2982	39	1.1 (1.1 to 1.2)	40	1.2 (1.2 to 1.3)	15	1.2 (1.1 to 1.4)	31	1.3 (1.2 to 1.4)	21	1.3 (1.2 to 1.4)	37	1.1 (1.0 to 1.2)	56	1.2 (1.1 to 1.2)
Pain in the past year preventing activity:															
Never smoked	6022	9	1.0	9	1.0	4	1.0	8	1.0	6	1.0	11	1.0	25	1.0
Formerly smoked	3121	12	1.2 (1.1 to 1.4)	14	1.3 (1.1 to 1.4)	7	1.4 (1.2 to 1.7)	12	1.3 (1.1 to 1.5)	8	1.1 (0.9 to 1.3)	13	1.0 (0.9 to 1.2)	38	1.3 (1.2 to 1.3)
Currently smoke	2951	16	1.5 (1.3 to 1.6)	17	1.5 (1.4 to 1.7)	7	1.6 (1.3 to 1.9)	13	1.4 (1.2 to 1.6)	10	1.4 (1.2 to 1.7)	15	1.2 (1.0 to 1.3)	37	1.3 (1.2 to 1.4)

*Number included in the analysis of neck pain. Numbers in the other analyses varied slightly according to the completeness of the responses on pain.

All PRs were adjusted for age, sex, and complaints of frequent headaches, tiredness, or stress. They were also adjusted for reported occupational activities (exposure to hand transmitted and whole body vibration in the past week; and reports in an average working day of: lifting weights > 10 kg by hand, work with hands above shoulder height for > 1 h, and use of a keyboard for > 4 h).

Similar findings have been reported in a few other investigations. In a survey of Norwegian households, musculoskeletal pains (in the back, neck, upper limb, lower limb, and at several of these sites) were reported more often by current and ex-smokers than never smokers, after allowance for age, sex, comorbidity, mental distress, and physical demands of work¹⁶; and somewhat higher risks were found in current than former smokers. Current smoking was also associated with incident pain (in the neck/shoulder region, low back, upper and lower limbs) in a five year follow up study from the metal industry, again after allowance for workload, mental distress, and occupation¹⁰; and, in a Swedish population survey, current smokers had a higher prevalence of chronic widespread pain than non-smokers (OR v non-smokers 1.60, 95%CI 1.04 to 2.46).²³ In each case a dose-response relationship was found with daily cigarette consumption.

Such a pattern requires an explanation beyond effects local to the intervertebral disc. The possibilities seem to fall into two broad categories: a pharmacological effect of tobacco smoke or a neuropsychological or sociocultural difference that varies systematically between those who become smokers and those who do not.

Nicotine is a psychostimulant which affects both cortical and autonomic arousal. Thus, it could affect the manner in which the brain processes sensory stimuli and the central perception of pain,²⁴ although studies of pain tolerance during experimental exposure to cigarettes and nicotine have reached inconsistent conclusions.²⁵⁻²⁷ Alternatively, tobacco smoking might cause general damage to musculoskeletal tissues through vasoconstriction, hypoxia, defective fibrinolysis, or other mechanisms that impair their nutrition or structure.^{2 10 16} We have found, in keeping with the survey of Brage *et al*,¹⁶ detectable effects in ex-smokers, and so a hypothesis that involves tissue damage or a prolonged resetting of the threshold for pain tolerance is better supported by the data than one which depends on transient pharmacological effects.

Another possibility is that subjects who choose to take up and continue smoking report pain at a lower threshold than lifetime non-smokers. For example, their willingness to articulate somatic symptoms or report them as disabling may differ systematically, reflecting differences of personality or illness behaviour (for example, neuroticism, extroversion, dependency behaviour, or tendency towards somatisation). If so, ex-smokers might be expected to offer responses closer to those of current smokers than lifetime non-smokers, and our data are consistent with this. Also in keeping with a confounding effect of this sort is a recent community survey in which adolescent smokers had multiple somatic symptoms, poorer self reported health, and greater use of healthcare services than did age matched non-smokers.²⁸

A few surveys have sought to assess pain tolerance according to smoking habits experimentally, using standardised painful stimuli, but the findings have been mixed. In the large Kaiser-Permanente Multiphasic Screening Programme, smokers were less tolerant than non-smokers of painful mechanical pressure on the Achilles tendon²⁹; and in a second smaller study, they reported intolerance sooner than non-smokers in response to an occlusive limb tourniquet.²⁴ But surveys of painful electrocutaneous stimulation have provided no evidence of a difference.^{30 31} Response to an experimental stimulus, however, is qualitatively different from that to inquiry about recent experience of pain.

One way to distinguish between the hypotheses of systemic effect and confounding by sociocultural factors might be to ascertain reported pain longitudinally in people who take up or give up smoking and compare it with those who maintain constant smoking habits. Investigations with this design have rarely been conducted, but in a survey from the metal industry, workers who gave up smoking during a 10 year follow up reported an increase in morbidity from widespread pain, whereas no change was reported by those who continued to

smoke.¹⁰ It seems possible that some subjects gave up their smoking because of poor health, but another explanation is that the threshold at which subjects report pain is modifiable by the central effects of tobacco smoke.

The associations that we have described are moderate in size, and may have arisen through confounding. Nevertheless, further investigation would be useful to clarify the findings, and to assess the implications for preventive advice and the direction of future research. If taking up smoking increases pain susceptibility, then this provides another reason to avoid the habit; but if the type of people who smoke report pain more readily, a search should next be made for the underlying mechanisms (and in particular the aspects of sociocultural difference that best explain the findings). This could be relevant both to helping people stop smoking and to understanding the mechanism of diffuse non-specific pain and the rising toll of musculoskeletal pain presenting to healthcare services.

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